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NATIONAL DAM SAFETY PROGRAM. LOWELL PIERCE DAM (MO 11009), MISS--ETC(U)
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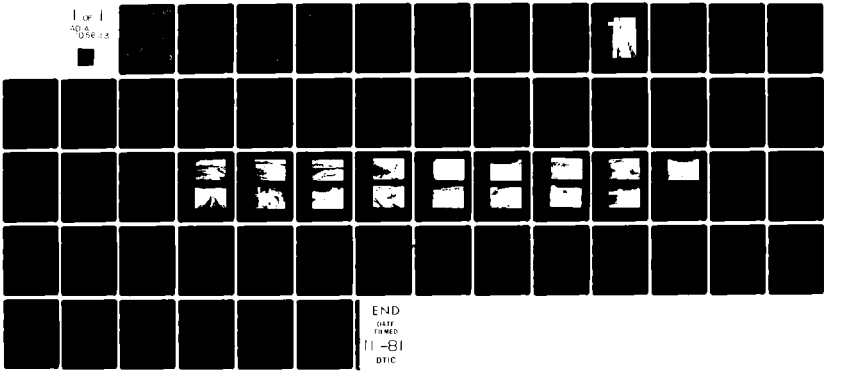

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LOWELL PIERCE DAM

ATCHISON COUNTY, MISSOURI

MO. 11009

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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LOWELL PIERCE DAM

ATCHISON COUNTY, MISSOURI

MO. 11009

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY
HOSKINS-WESTERN-SONDEREGGER, INC.
CONSULTING ENGINEERS
LINCOLN, NEBRASKA

UNDER DIRECTION OF

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

MAY, 1979

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Lowell Pierce Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Lowell Pierce Dam:

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District because of the following deficiencies:

1) Spillway will not pass the Probable Maximum Flood without overtopping. Overtopping could result in dam failure which would significantly increase the hazard to loss of life downstream.

2) Slope failure of a portion of the embankment. This decreases the stability of the dam which increases the likelihood of failure.

SUBMITTED BY: SIGNED — 13 DEC 1979
Chief, Engineering Division — Date

APPROVED BY:) — 13 DEC 1979
Colonel, CE, District Engineer — Date

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Lowell Pierce Dam
State Located	Missouri
County Located	Atchison County
Stream	Tributary Mill Creek
Date of Inspection	May 16, 1979

Lowell Pierce Dam was inspected by an interdisciplinary team of engineers from Hoskins-Western-Sonderegger, Inc. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as an intermediate size dam with a high downstream hazard potential. Failure would threaten life and property. The estimated damage zone extends approximately 1.6 miles downstream of the dam. Within the damage zone are County Road "Z", one dwelling and Interstate Highway 29.

The large slide and seepage on the right side of the downstream section indicate that this dam is not structurally stable from the standpoint of shear strength and seepage pressures. Seepage and stability analyses including earthquake loadings, comparable to the requirements of the "Recommended Guidelines for Safety Inspections of Dams" should be performed as soon as possible. These analyses are required to design the remedial measures necessary to reconstruct and stabilize the downstream section of the dam and the principal spillway (pipe) outlet.

Our inspection and evaluation indicates that the spillway does not meet the criteria set forth in the recommended guidelines for an intermediate size dam having a high hazard potential. The full Probable Maximum Flood is the appropriate spillway design flood. The spillways will pass the 100-year flood (flood having a one percent chance of being exceeded in any year) without overtopping the dam. The spillways will pass 16% of the Probable Maximum Flood without overtopping the dam. The Probable Maximum Flood (PMF) is defined as the flood that may be expected from the most severe combination of critical meterologic and hydrologic conditions that are reasonably possible in the region.

The materials in the embankment and in the emergency spillway are highly erosive under low velocity flows. This induces a very high potential of failure of the dam if it overtops and of breaching the reservoir by erosional headcutting through the emergency spillway if the spillway operates under prolonged flows. It is recommended that actions necessary to minimize or eliminate the potentials of failure by overtopping the dam or by spillway breaching be pursued on a high priority basis. Such actions should consider but not be limited to, increasing the height of the dam and the crest of the emergency spillway to temporarily impound the PMF without spillway discharges or to construct an erosion resistant spillway.

Other deficiencies observed during the inspection that should be corrected are: erosional gullies in the left upstream abutment trough; erosion of the upstream face of the dam; seepage in the left downstream abutment trough along the toe and downstream from the dam; and clogging of the channel downstream from the dam by trees and brush.

A program of regular inspection and maintenance should be initiated as soon as the above deficiencies have been corrected.

Rey S. Decker
E-3703

Gordon Jamison

Gordon Jamison

Harold Ulmer

Garold Ulmer
E-4777

H. P. Hoskins

Harold P. Hoskins
Chairman of Board
Hoskins-Western-Sonderegger, Inc.
E-8696

PHOTO NO. 1 - OVERVIEW TAKEN FROM UPSTREAM ON RIGHT.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LOWELL PIERCE DAM - MO 11009
ATCHISON COUNTY, MISSOURI

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of Lowell Pierce Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams", Appendix D to "Report of the Chief of Engineers on the National Program of Inspection of Dams", dated May, 1975, and published by the Department of the Army, Office of the Chief of Engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earthfill, approximately 310 feet in length and about 45 feet in height. It is constructed in a nearly vertical walled channel, deeply incised through loess and loessal alluvium, which is the typical erosional pattern in deep loessal areas.

(2) The principal spillway consists of a 48-inch diameter corrugated metal pipe (CMP) riser about 4 feet high connected with a 12-inch diameter welded steel pipe outlet conduit passing through the dam. A low-level inlet notch 1 ft. deep and 1.7 ft. wide is cut into the riser crest.

(3) A poorly vegetated earth emergency spillway is cut into the right abutment.

(4) Pertinent physical data are given in paragraph 1.3 below.

b. Location. The dam is located in the southwestern portion of Atchison County, Missouri, as shown on Plate A-2. The dam is shown on Plate A-1 in the NW ¼ of Section 36, T64N, R41W. The lake formed behind the dam is shown in the NW ¼ of Section 36, T64N, R41W, the NE ¼ of Section 35, T64N, R41W, and the SE ¼ of Section 26, T64N, R41W.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, this dam and impoundment is in the intermediate size category.

d. Hazard Classification. Guidelines for determining hazard classification are presented in the same guidelines as referenced in paragraph 1.1c above. Based on referenced guidelines, this dam is in the High Hazard Classification. The estimated damage zone extends approximately 1.6 miles downstream of the dam. Within the damage zone are county road "Z" and one dwelling. The subject drainageway enters the much larger Mill Creek at the county road. One mile below this confluence Mill Creek crosses under Interstate 29.

e. Ownership. The dam is owned by Lowell Pierce, Rockport, Missouri 64482.

f. Purpose of Dam. The dam was constructed as an erosion control and grade stabilization structure to reduce the gulley and head cutting erosion of tributary drainageways.

g. Design and Construction History. The owner reported that the dam was constructed in 1968 or 1969 as part of the Agricultural Stabilization and Conservation Service (ASCS) program. However, this structure was not cost shared by ASCS due to insufficient funds. No design information was available.

h. Normal Operating Procedure. All spillways are uncontrolled and there are no operating procedures for this dam. The pool level is controlled by rainfall, infiltration, evaporation, and the capacity of the uncontrolled spillways.

1.3 PERTINENT DATA

a. Drainage Area. 694 acres (1.084 square miles).

b. Discharge at Damsite.

(1) All discharges at the damsite are through a principal spillway consisting of a 48-inch diameter corrugated metal pipe riser connected with a 12-inch diameter welded steel pipe outlet and a grassed earth channel ungated emergency spillway.

(2) Estimated maximum flood. The estimated maximum spillway discharge during the maximum flood as described by the owner was approximately 18 c.f.s. This implies that the maximum flood must have been less than the 100-year (1 percent) flood.

(3) The principal spillway capacity varies from 0 c.f.s. at elevation 960.0 feet to 20 c.f.s. at the crest of the emergency spillway (elevation 967.2) to 20 c.f.s. at the minimum top of dam (elevation 969.7).

(4) The emergency spillway capacity varies from 0 c.f.s. at its crest elevation 967.2 to 357 c.f.s. at elevation 969.7 (minimum top of dam).

(5) Total spillway capacity at the minimum top of dam is 377 c.f.s. ±

c. Elevations. (Feet above M.S.L.)

(1) Top of dam - 970 ±
(2) Principal spillway crest - 961 ±
(3) Emergency spillway crest - 967 ±
(4) Streambed at centerline - 925 ±
(5) Maximum tailwater - unknown

d. Reservoir. Length (feet) of maximum pool - 8,300 ±.

e. Storage (Acre-feet).

(1) Top of dam - 193 ±
(2) Principal spillway crest - 0 ±

f. Reservoir Surface (Acres).

(1) Top of dam. 25 ±
(2) Principal spillway crest - 13 ±

g. Dam.

(1) Type - Earthfill
(2) Length - 310 ft. ±
(3) Height - 45 ft. ±
(4) Top Width - 16 ft. ±
(5) Side slopes.
    (a) Downstream 2.2H on 1V (measured)
    (b) Upstream 3H on 1V (measured on exposed section)
(6) Zoning - unknown
(7) Impervious core - unknown
(8) Cutoff - unknown
(9) Grout curtain - unknown
(10) Wave protection - none

h. Diversion Channel and Regulating Tunnel. None

i. Spillway.

(1) Principal

    (a) Type - drop inlet with 48-inch diameter riser and 12-inch diameter conduit. 1 ft. x 1.7 ft. notch cut into crest of riser.

    (b) Crest (invert) elevation - 961 ft., notch = 960 ft. Outlet - submerged, estimated at 925 ±

    (c) Length - 150 ft. ±

(2) Emergency

    (a) Type - vegetated earth located on the right end of the dam.

    (b) Control section - trapezoidal section with bottom width of 30 ft. ± and side slopes of 4H on 1V and 1.5 to 2H on 1V.

    (c) Crest elevation 967 ft. ±

    (d) Upstream Channel - open, excavated earth, with slope of 12% ±

(e) Downstream Channel - the spillway outlets over a vertical gulley headcut about 15 feet deep in the loessal alluvium of the old channel bank.

j. Regulating Outlets. None.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design data were available for this dam.

2.2 CONSTRUCTION

No construction data were available. It was reported by Lowell Pierce that the dam was constructed in 1968 or 1969, and that sheepsfoot rollers were used on the embankment.

2.3 OPERATION

No data were available on spillway operation. It was reported by Lowell Pierce that water has never passed through the emergency spillway. It was reported that the highest reservoir level occurred in 1973 or 1974 when the water raised about two feet over the crest of the principal spillway, and that there has been only one year that the lake level dropped below the inlet to the pipe spillway.

2.4 EVALUATION

a. Availability. No data were available.

b. Adequacy. The field surveys and visual observation presented herein are considered adequate to support the conclusion of this report. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity. Not applicable.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the Lowell Pierce Dam was made on May 16, 1979. Engineers from Hoskins-Western-Sonderegger, Inc. Lincoln, Nebraska making the inspection were: R.S. Decker, Geotechnical; Gordon Jamison, Hydrology; and Garold Ulmer, Civil Engineer. Mr. Lowell Pierce, Owner, was present during the inspection.

b. Dam.

(1) Geology & Soils (Abutment & Embankment). The dam is located in the deep loess hills of northwestern Missouri. The old channel is deeply and almost vertically incised through loess and loessal alluvium. These loessal deposits of the old channel banks form the abutments for the dam. Materials in the abutments and the embankment are low plasticity CL-ML soils. Fine grained glacial till appeared to outcrop near the valley bottom on the right abutment.

(2) Upstream Slope. The upstream slope is fairly well vegetated with adapted grasses. Surface drainage into the reservoir from the left abutment has cut several gullies and rills up to 2 feet in depth. Photo No. 2 shows the gullies and rills. Some erosion was noted along the waterline. No cracks, settlements, sink holes, rodent holes or abnormal deformations were noted.

(3) Crest. The crest serves as an access road across the dam. The right end of the crest is about 1 ft. higher than the left end. No cracks, deformations or significant erosion were noted on the crest. Photo No. 3 shows the crest of the dam.

(4) Downstream Slope. The downstream slope is well vegetated except for the slide area in the right abutment trough. The slide or slump in the right abutment trough (see Photos 4 and 13) has removed a section of the dam about 60 feet wide extending from about one-half way down the slope from the crest to the toe. The owner reported that this slide occurred the first winter after the dam was constructed and hasn't progressed very much since then. The slide covered the outlet end of the principal spillway pipe, which is still submerged. Seepage outcrops in the slide or slump area at about elevation 938 feet which would be about one-third of the way up from the toe, as normally expected. Seepage from the right

abutment and slide area is estimated to be 0.25 gal./min. Seepage outcrops on the left abutment at about elevation 944 ft. some 5 or 6 feet higher than the outcrops on the right end. Seepage on the left end extends from the abutment trough along the toe of the dam to about Sta. 0+80 and downstream from the toe for some distance. Seepage from the left abutment and toe area was estimated at about 0.5 to 0.75 gal./min. All seepage was clear and no boils were observed. No deformations were noted in the left and center sections of the downstream slope. However, the near vertical left valley (old gulley) bank is sluffing for some distance downstream from the dam.

(5) Miscellaneous. The nature of materials in this dam and present conditions indicate that any significant overtopping would probably cause considerable damage and possible failure of the structure.

c. Appurtenant Structures.

(1) The principal spillway consists of a 48-inch CMP riser with notch as described previously with 12-inch steel outlet pipe passing through the embankment. No deterioration was noted in the metal riser or pipe. The trash rack consisted of a cage of woven wire. The inlet was reasonably free of trash.

The outlet end of the pipe is submerged and was not located. Water was flowing through the notch in the riser at an estimated rate of 5 gal./min.

(2) The emergency spillway is cut through the right abutment. The vegetative cover in the spillway is only fair and surface runoff into the spillway has caused some erosion. Materials in the spillway are CL-ML soils. The exit channel drops off into the valley over a 15-foot deep headcut which is badly eroded.

(3) Drawdown Facilities. There are no drawdown facilities for this dam.

d. Reservoir Area. The reservoir extends several thousand feet upstream and consists largely of deep channel storage. The old channel banks were near vertical and some sloughing and erosion must result around the edge of the reservoir, as observed near the dam. However, the water in the reservoir is very clear.

e. Downstream Channel. The downstream channel is badly overgrown with trees and shrubs.

3.2 EVALUATION

It would appear that any increase in seepage pressures caused by higher reservoir levels would result in serious potential of failure in the slide area on the right end of the dam. Such increased pressures could also cause slides in the left abutment area. It would also appear that any significant flow through the emergency spillway would result in advancing the outlet headcut toward the reservoir. However, the headcut would have to advance some 150 feet to cause drawdown of the reservoir. Significant overtopping would probably result in potential of failure.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no controlled outlet works for this dam. The pool level is controlled by rainfall, infiltration, evaporation, and the capacity of the uncontrolled spillways.

4.2 MAINTENANCE OF DAM

There are no regular maintenance procedures for this dam as evidenced by erosion on the upstream slope and lack of repair of the slide area in the right abutment downstream section.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system in effect for this dam.

4.5 EVALUATION

There appears to be a potential of failure of this structure.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. No design data were found for this dam. Therefore, all computations are based on the field inspection and survey performed by the consultant. The plans, profiles, and cross sections from the survey are attached in Appendix C.

b. Experience Data. The drainage area, reservoir surface area, and elevation-storage data were developed from the USGS Tarkio, Missouri 15 minute topographic quadrangle map. The hydraulic computations for the spillway and dam overtopping discharge ratings were based on data collected in the field at the time of the field inspection.

c. Visual Observations.

(1) The principal spillway inlet was encaged with a woven-wire fabric fence for a trash rack. The inlet was reasonably clear of debris.

(2) The slide in the right abutment trough had completely buried the principal spillway outlet. The spillway, however, was discharging at a rate of about 5 gallons per minute. We could not locate the actual location of the outlet. The bottom of the pool was approximately 3.5 feet below the water surface.

(3) The emergency spillway and exit channel are located in the right abutment of the dam.

(4) The exit channel from the emergency spillway drops off at the edge of the old gulley channel bank. The drop-off falls vertically a distance of about 15 feet and is very seriously eroded. Any significant flow through the spillway would headcut this gulley back into the reservoir.

(5) The downstream channel was badly choked with trees and brush.

(6) No drawdown facilities are available to evacuate the pool.

d. Overtopping Potential. The spillways are too small to pass 100% of the probable maximum flood without overtopping. The

spillways will pass 16% of the PMF without overtopping. The 100-year (1 percent) peak outflow discharge is approximately 20% of the spillway capacity. Significant overtopping of this dam would probably result in potential of failure. The results of the routings through the dam are tabulated in regards to the following conditions.

Frequency	Inflow Discharge c.f.s.	Outflow Discharge c.f.s.	Maximum Pool Elevation	Freeboard Top of Dam Min. Elev. 969.7	Time Dam Overtopping Hr.
100 Yr.	1500	70	968.0	+1.7	0
1/2 PMF	3700	3500	972.1	-2.4	5+
PMF	7500	7200	973.4	-3.7	7+
0.16 PMF	1200	350	969.7	0	0

According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, this dam is classified as having a high hazard rating and an intermediate size. Therefore, the PMF is the test for the adequacy of the dam and its spillway.

The estimated damage zone is described in Paragraph 1.2d in this report.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observation. The slide in the right downstream section and the resulting steepened slope and seepage would indicate that this dam is not structurally stable.

b. Design and Construction Data. No design or construction data were available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Operating Records. There are no controlled operating facilities for this dam.

d. Post Construction Changes. The inspection team is not aware of any post construction changes for this structure.

e. Seismic Stability. This dam is located in Seismic Zone 1. Additional studies would be required to determine the effects of an earthquake of the magnitude predicted in this area on the stability of this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. This dam is not considered to be structurally stable from the standpoint of shear strength and seepage pressures. Additional studies would be required to determine the adverse affects of overtopping or significant emergency spillway flows on the safety of the structure against breaching, but it appears that such flows would induce a high potential of failure of this structure.

b. Adequacy of Information. Due to the lack of engineering data, the conclusions in this report are based upon performance history and visual observations. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. Because of the potential for further embankment failure in the area of the slump at the right abutment, steps should be taken immediately to correct this deficiency. A program should be developed as soon as possible to monitor the other deficiencies described in this report. The actions recommended in paragraphs 7.2a(2) and 7.2a(3) should be pursued on a high priority basis."

d. Necessity for Phase II. Phase II investigation is not considered necessary.

e. Seismic Stability. This dam is located in Seismic Zone 1. Additional studies would be required to assess the affects of such an earthquake on the structural stability of this dam.

7.2 REMEDIAL MEASURES

a. Alternatives.

(1) Structural stability and seepage analyses for the design and rehabilitation of the downstream section of the dam and the abutments should be made. Stability analyses should include seismic considerations.

(2) The effects of overtopping and of emergency spillway flows on the erosional stability and safety of the dam and abutments against breaching should be evaluated.

(3) Consideration should be given to increasing the height of the dam and the emergency spillway crest to temporarily impound the probable maximum flood without overtopping or causing emergency spillway flow in accordance with the results of studies for item 2, above. These evaluations concerning impoundment and overtopping should include detailed evaluation of the topographic characteristics of the reservoir area.

(4) The services of an Engineer experienced in the design and construction of earth dams should be obtained to evaluate the present dam and spillway, make the necessary analyses and to design the required protective measures.

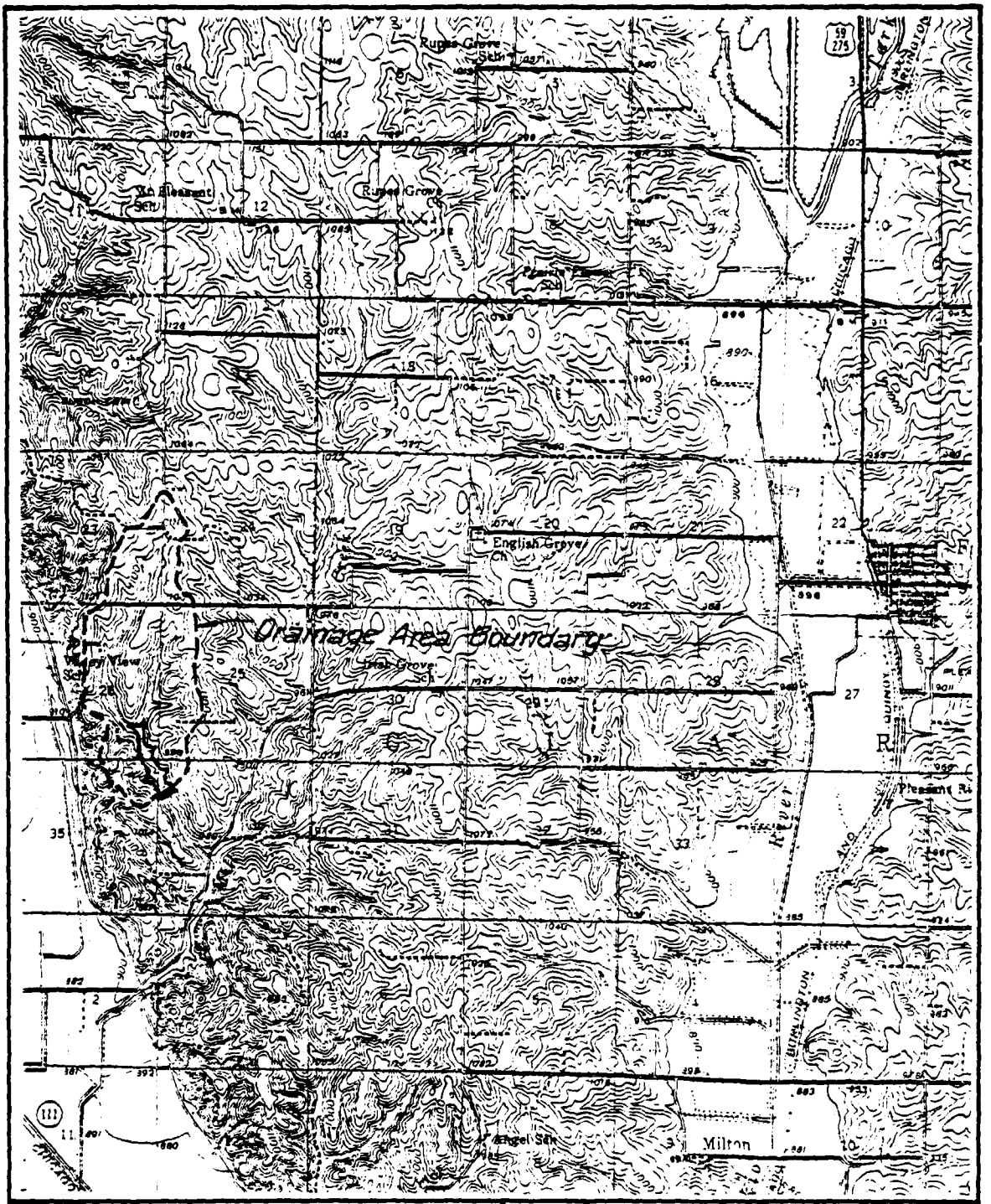
b. O & M Procedures.

(1) Erosion on the upstream slopes of the dam and abutment troughs should be corrected.

(2) Some clearing of trees and brush in the downstream channel should be done to prevent encroachment of emergency spillway discharge on the toe of the dam. Such clearing should be done in accordance with the actions taken in paragraph 7.2 above.

(3) A program of regular inspection and maintenance should be initiated to prevent excessive erosion of the embankment, emergency spillway, and abutments.

APPENDIX A
MAPS



Scale in feet

5000 2500 0 5000 10,000

Contour Interval 20 Feet

N

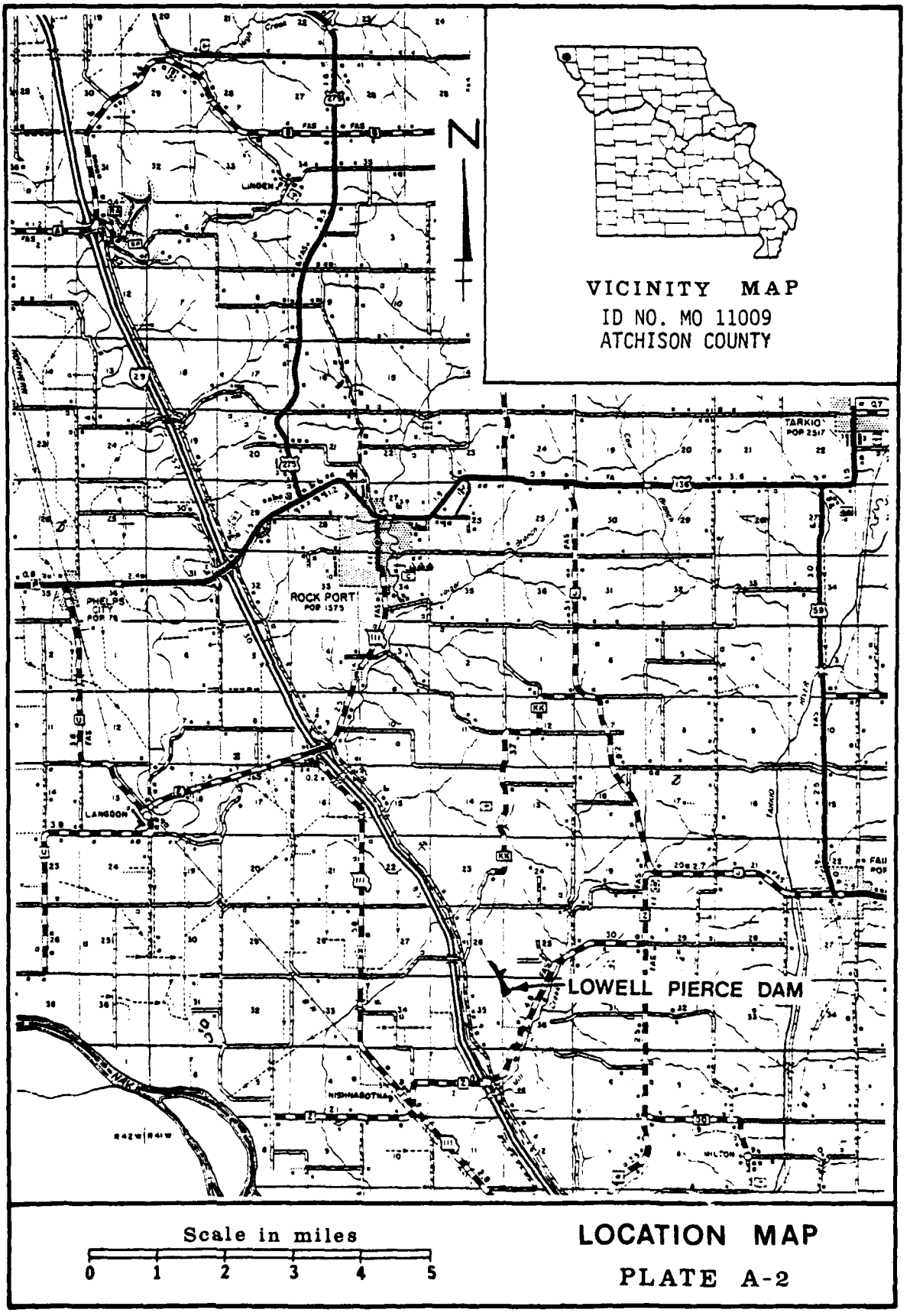
VICINITY TOPOGRAPHY

LOWELL PIERCE DAM

ATCHISON COUNTY, MISSOURI

MO. 11009

PLATE A-1


N
VICINITY MAP
ID NO. MO 11009
ATCHISON COUNTY
ROCK PORT
POP 1575
PHELPS CITY
POP 76
TARKIO
POP 2317
LANGDON
LOWELL PIERCE DAM
NISHNABOTNA
R42W
R41W
Scale in miles
0 1 2 3 4 5
LOCATION MAP
PLATE A-2

APPENDIX B
PHOTOGRAPHS

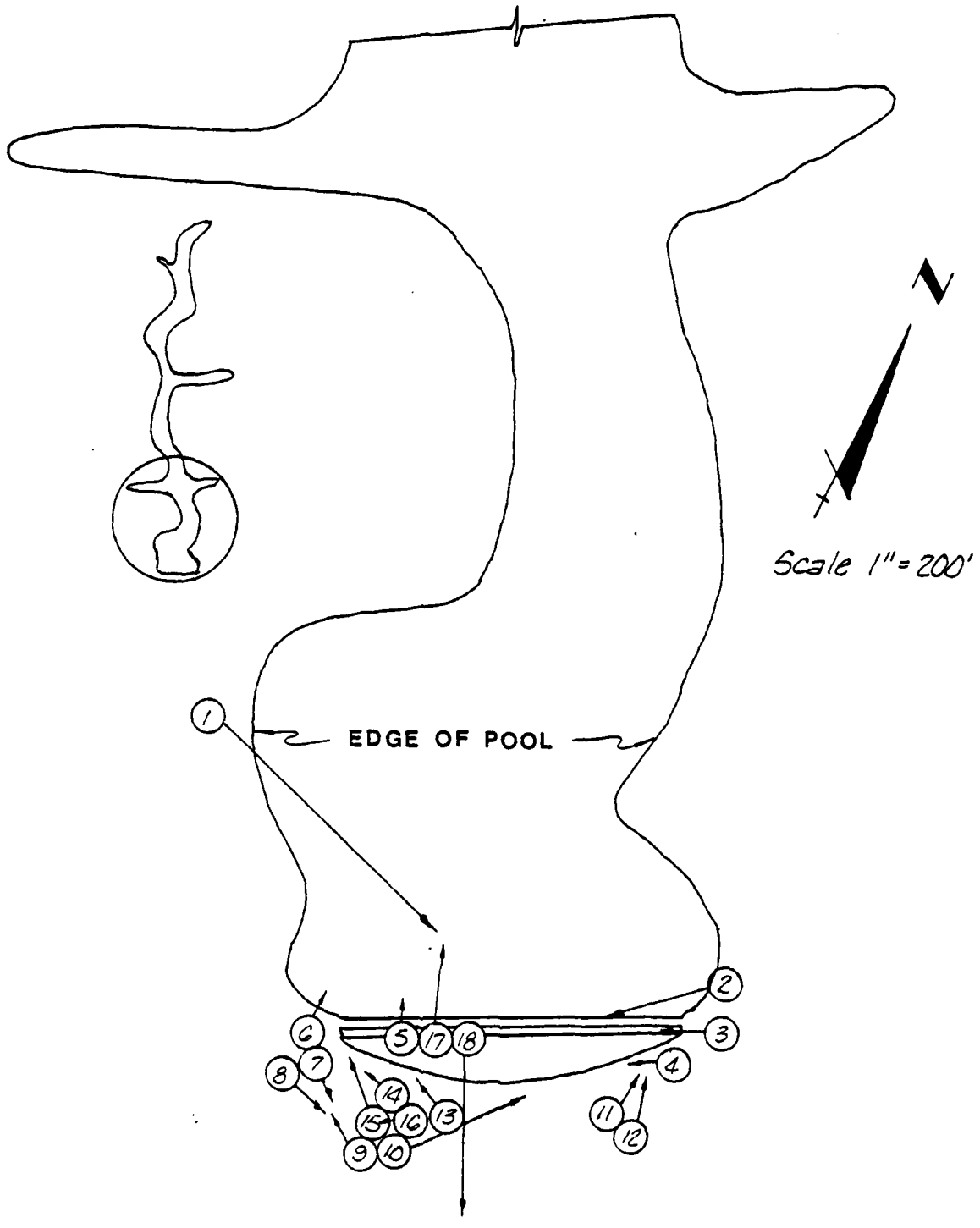


PHOTO INDEX

LOWELL PIERCE DAM

ATCHISON COUNTY, MISSOURI

MO. 11009

PLATE B-1

PHOTO NO. 2 - UPSTREAM FACE FROM LEFT ABUTMENT.

PHOTO NO. 3 - CREST TAKEN FROM LEFT END.

PHOTO NO. 4 - DOWNSTREAM FACE FROM LEFT ABUTMENT SHOWING SLIDE NEAR RIGHT ABUTMENT.

PHOTO NO. 5 - PRINCIPAL SPILLWAY RISER.

PHOTO NO. 6 - LOOKING UPSTREAM IN EMERGENCY SPILLWAY.

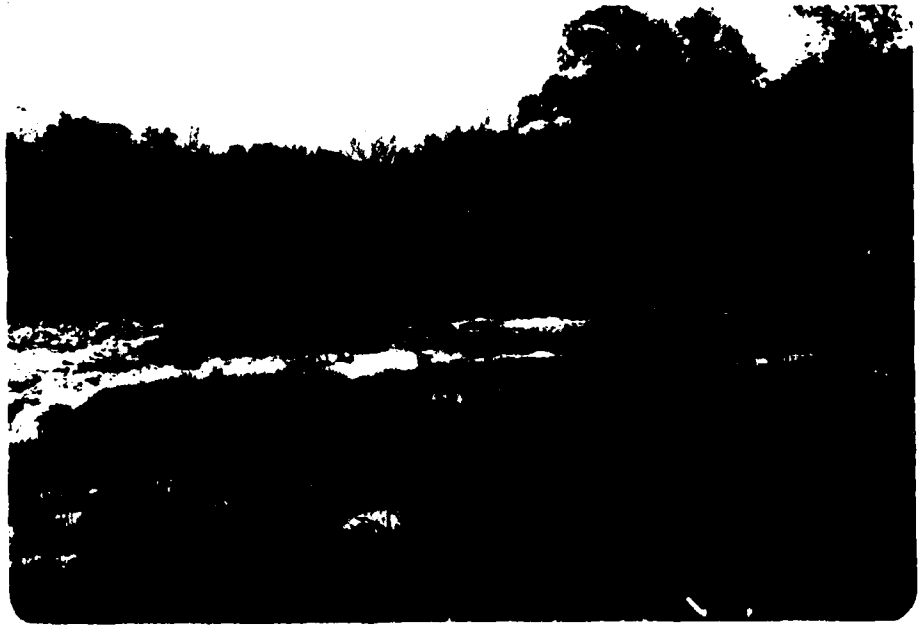


PHOTO NO. 7 - LOOKING DOWNSTREAM IN EMERGENCY SPILLWAY.

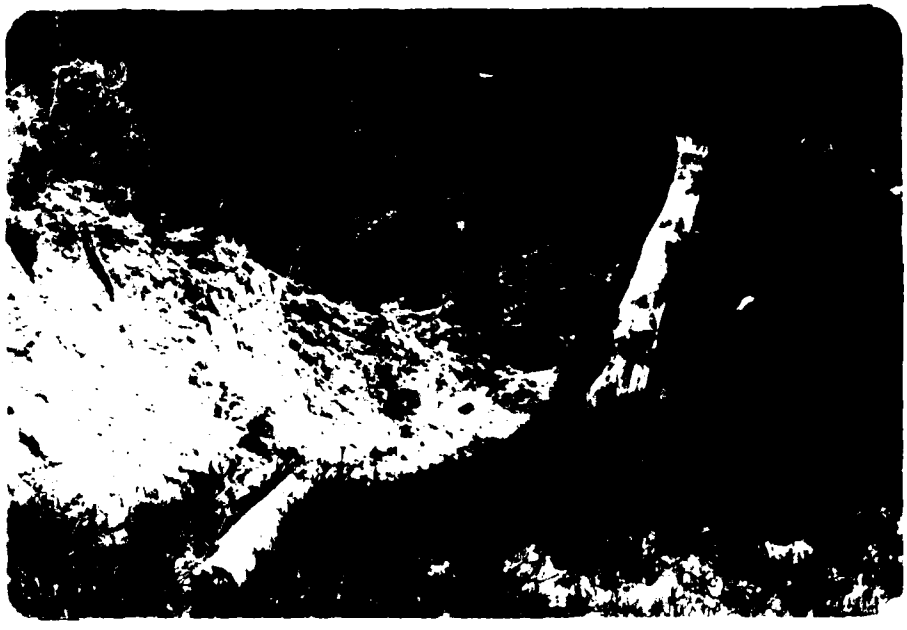


PHOTO NO. 8 - EXIT CHANNEL OF EMERGENCY SPILLWAY.
15 FOOT VERTICAL DROP-OFF & SERIOUS EROSION.

PHOTO NO. 9 - LOOKING UPSTREAM IN EXIT CHANNEL. SHOWING
HEAD CUT.

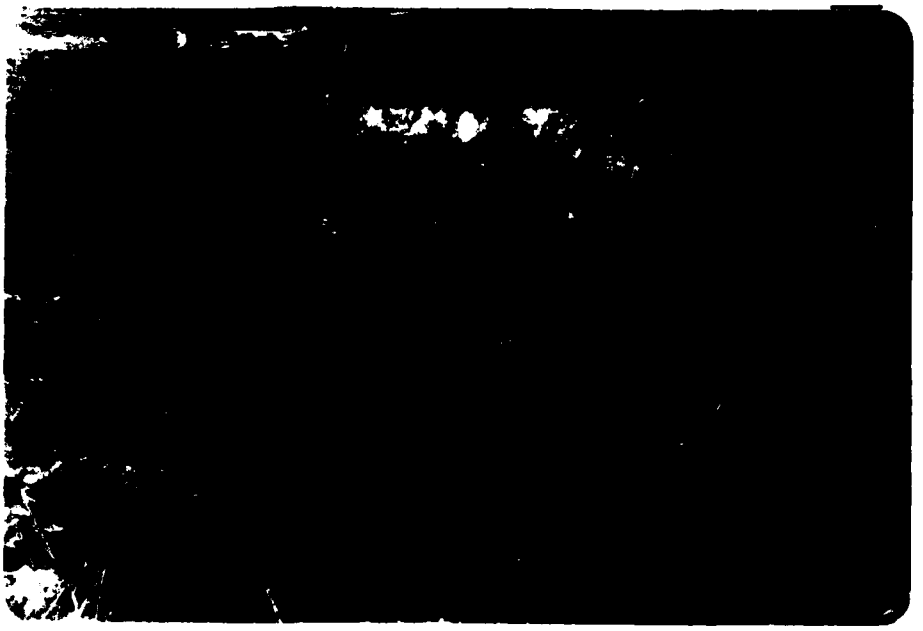


PHOTO NO. 10 - DOWNSTREAM SLOPE FROM RIGHT ABUTMENT.

PHOTO NO. 11 - SEEPAGE SPOT AT DOWNSTREAM TOE IN LEFT ABUTMENT.

PHOTO NO. 12 - SEEPAGE AT TOE IN LEFT ABUTMENT.

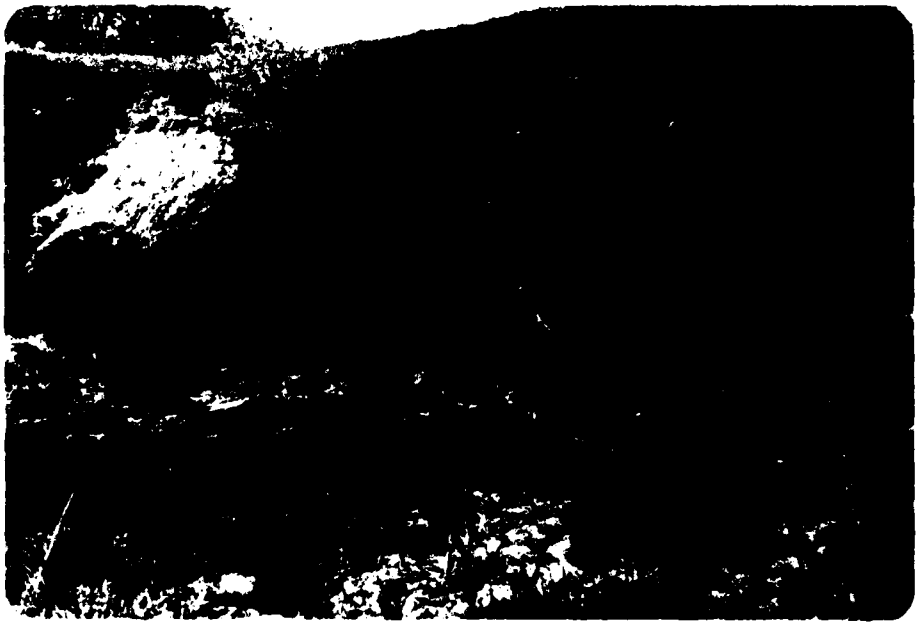


PHOTO NO. 13 - SLIDE AND ERODED AREA IN RIGHT ABUTMENT TROUGH DOWNSTREAM.

PHOTO NO. 14 - SEEPAGE FROM SLIDE AREA IN RIGHT ABUTMENT TROUGH.

PHOTO NO. 15 - PRINCIPAL SPILLWAY PIPE AT LOWER RIGHT CORNER. OUTLET END COMPLETELY SUBMERGED.

PHOTO NO. 16 - PRINCIPAL SPILLWAY OUTLET. PIPE SUBMERGED.

PHOTO NO. 17 - UPSTREAM FROM CREST OF DAM.

PHOTO NO. 18 - DOWNSTREAM FROM STA. 2+50.

APPENDIX C
PROJECT PLATES

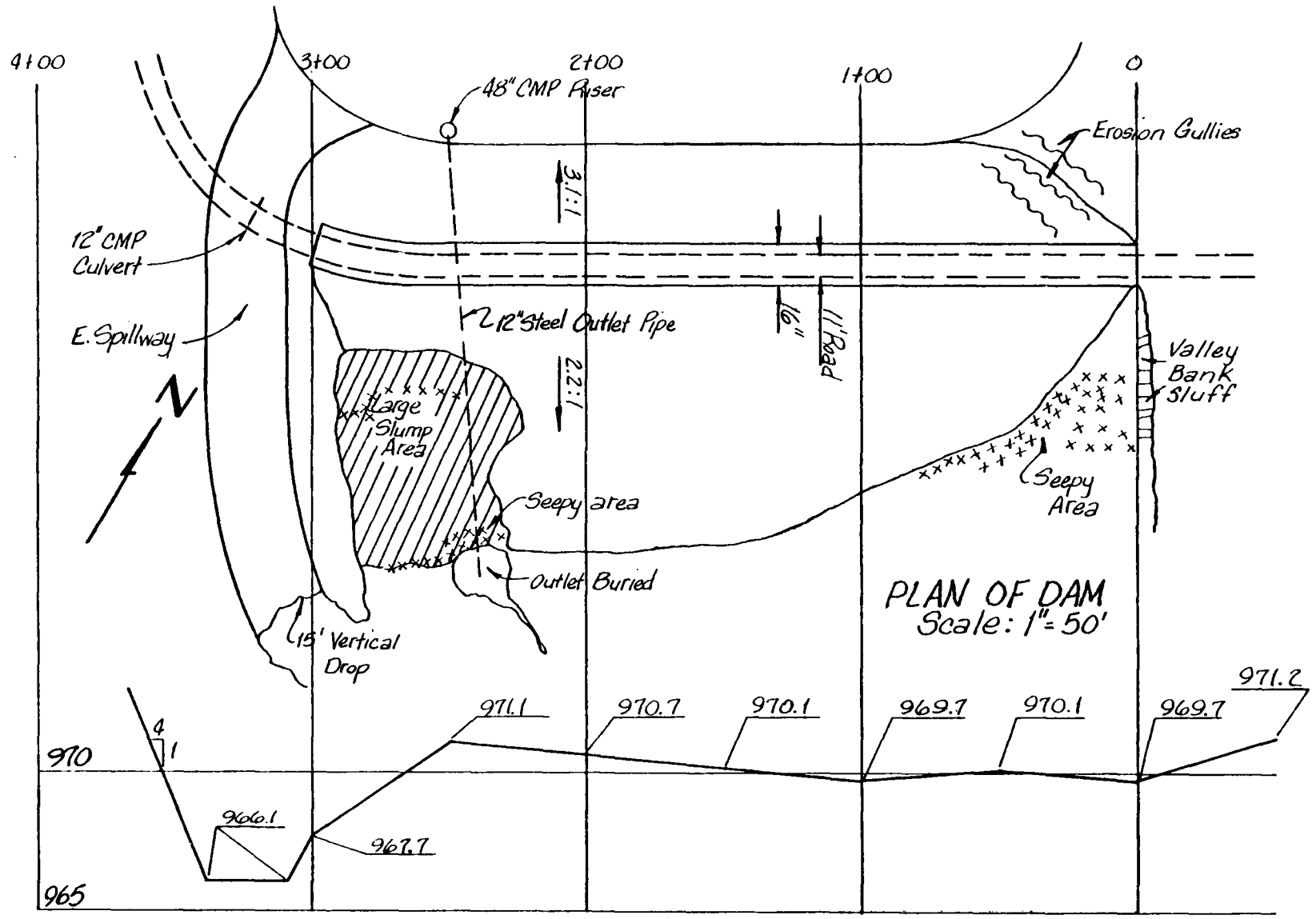
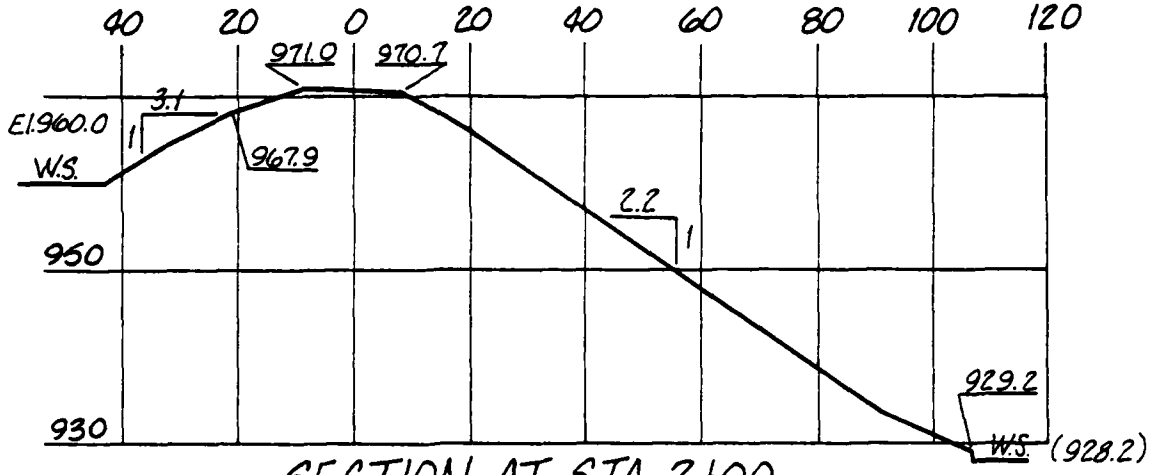
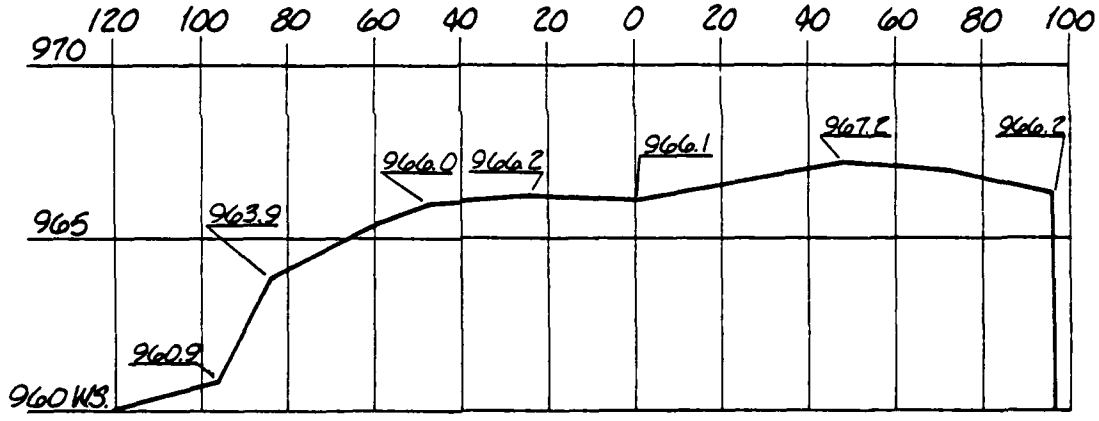

4+00
3+00
2+00
1+00
0
48" CMP Riser
Erosion Gullies
3:1
12" CMP Culvert
E. Spillway
12" Steel Outlet Pipe
16"
11' Road
2.2:1
Valley Bank Sluff
Large Slump Area
Seepy area
Seepy Area
Outlet Buried
15' Vertical Drop
PLAN OF DAM
Scale: 1" = 50'
971.2
971.1
970.7
970.1
969.7
970.1
969.7
4
1
970
966.1
967.7
965
PROFILE ALONG CENTERLINE OF DAM
Scale: 1" = 50' H.
1" = 5' V.

PLATE C-1



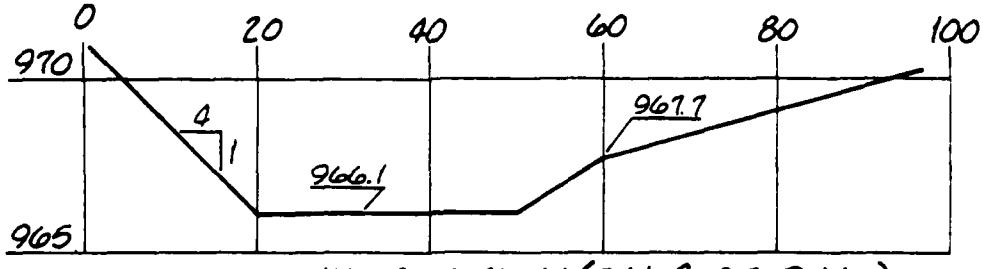
SECTION AT STA. 2+00

Scale: 1" = 30' H.
1" = 20' V.



℄ PROFILE OF SPILLWAY

Scale: 1" = 40' H.
1" = 5' V.



SPILLWAY SECTION (ON ℄ OF DAM)

Scale: 1" = 20' H. 1" = 5' V.

PLATE C-2

APPENDIX D
HYDRAULIC AND HYDROLOGIC DATA

HYDROLOGIC COMPUTATIONS

1. The SCS dimensionless unit hydrograph and the systemized computer program HEC-1 (Dam Safety Version), July, 1978, prepared by the Hydrologic Engineering Center, U.S. Corps of Engineers, Davis, California, were used to develop the inflow hydrographs.

   a. The twenty-four hour, 100-year rainfall for the dam location was taken from the data for the rainfall station at Maryville, Mo. as supplied by the St. Louis District, Corps of Engineers per their letter dated 6 March 1979. The twenty-four hour probable maximum precipitation was taken from the curves of Hydrometeorological Report No. 33 and current Corps of Engineers and St. Louis policy and guidance for hydraulics and hydrology.

   b. Drainage area = 1.08 square miles (694 acres).

   c. Time of concentration of runoff = 48 minutes (computed from "Kirpich" formula).

   d. The antecedent storm conditions for the probable maximum precipitation were heavy rainfall and low temperatures which occurred on the previous 5 days (SCS AMC III). The antecedent storm conditions for the 100-year precipitation were an average of the conditions which have preceded the occurrence of the maximum annual flood on numerous watersheds (SCS AMC II). The initial pool elevation was assumed at the sill of the riser of the principal spillway.

   e. The total twenty-four hour storm duration losses for the 100-year storm were 3.71 inches. The total losses for the PMF storm were 2.33 inches. These data are based on SCS runoff curve No. 83 and No. 67 for antecedent moisture conditions SCS AMC III and AMC II respectively. The watershed is composed of primarily SCS soil group B (Marshall-Judson-Kennebec Soils) and consists mostly of woods and pasture with very little of the watershed in cropland.

   f. Average soil loss rates = 0.10 inch per hour approximately (for PMF storm, AMC III).

2. The combined discharge rating consisted of three components: the flow through the principal spillway, the flow through the emergency spillway and the flow going over the top of the dam.

a. The principal spillway rating was developed by using the weir and full conduit flow equations.

1. Weir flow equation ($Q = CLH^{1.5}$)
where C = weir coefficient = 3.1
L= effective weir length, ft. = 12.6
H = total head, ft.

2. Full conduit flow equation

$$Q = a\sqrt{\frac{2gH}{1 + K_e + K_b + K_pL}}$$

where a = cross-sectional area of pipe, ft^2 = 0.785
H = total head, ft.
K_e = coefficient for entrance loss = 0.5
K_b = coefficient for bend loss = 0.45
K_p = coefficient for pipe friction loss = 0.0185
L = length of pipe, ft. = 150

b. The emergency spillway rating was developed using the Corps of Engineers Surface Water Profile HEC-2 computer program.

c. The flows over the dam are based on the broad-crested weir equation ($Q = CLH^{1.5}$) where H is the head on the dam crest, L is the effective length acting as a weir, and C is an appropriate weir coefficient which varies with head and is based on U.S. Geological Survey criteria. The weir coefficient varied from 2.56 to 3.04 while the effective length varied from 20 to 50 feet with an overall length of 310 feet.

3. Floods were routed through the reservoir using the HEC-1 (Dam Safety Version) program to determine the capabilities of the spillway and dam embankment crest. The output and plotted hydrographs are shown attached in this Appendix.

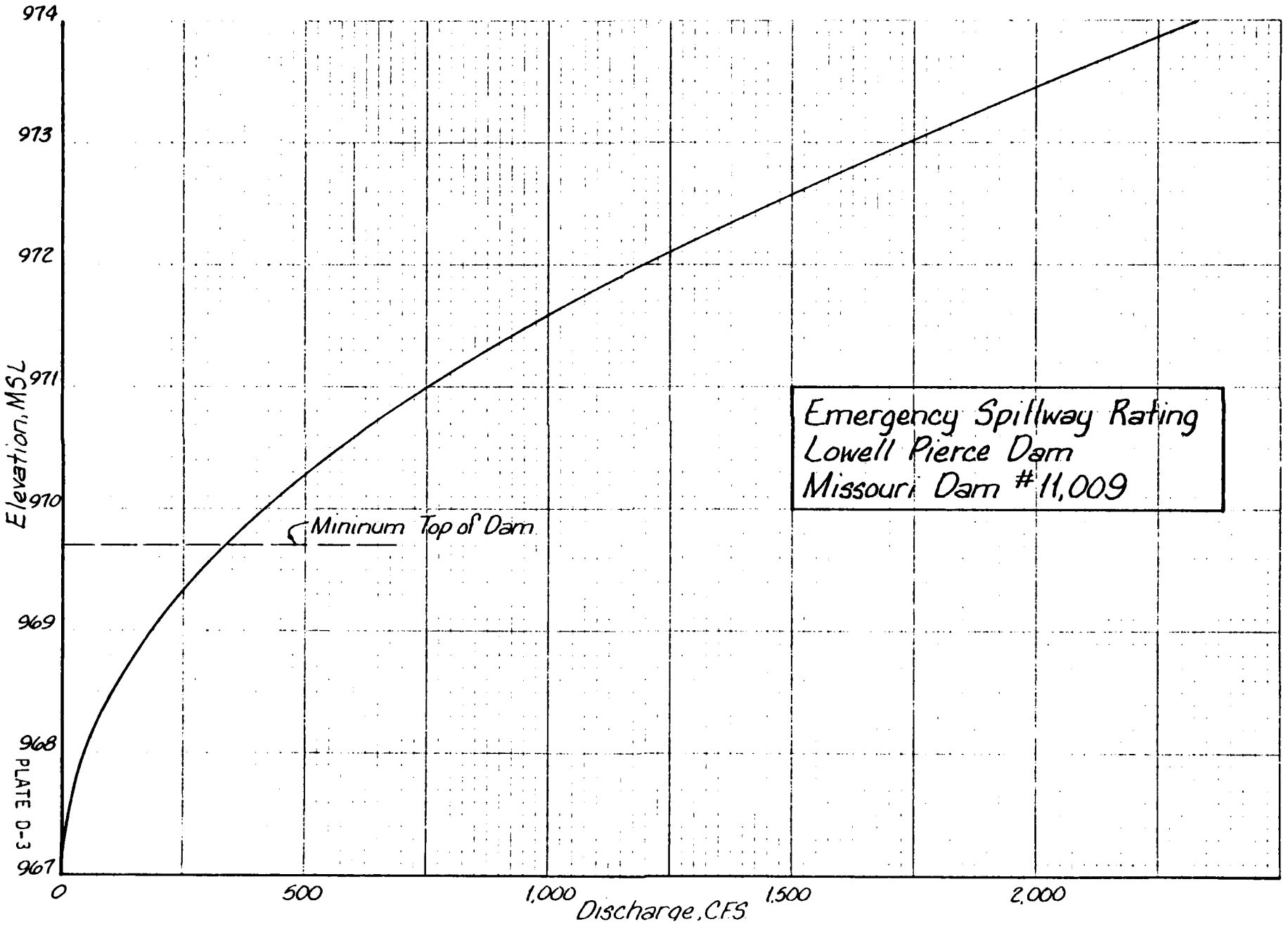
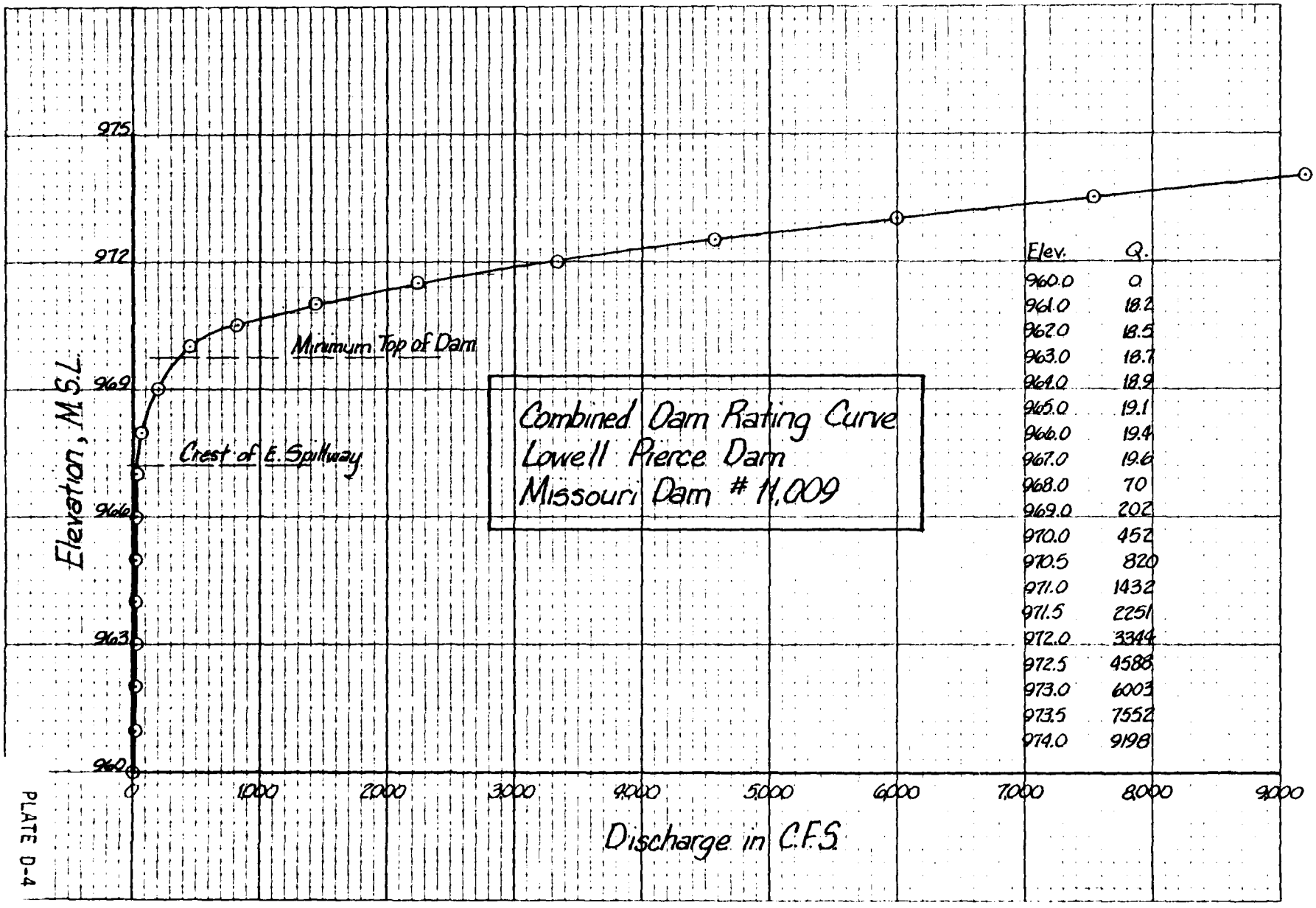

974
973
972
971
970
969
968
967
Elevation, MSL
Minimum Top of Dam
0
500
1,000
1,500
2,000
Discharge, CFS
Emergency Spillway Rating
Lowell Pierce Dam
Missouri Dam #11,009

PLATE D-3



Elev.	Q.
960.0	0
961.0	18.2
962.0	18.5
963.0	18.7
964.0	18.9
965.0	19.1
966.0	19.4
967.0	19.6
968.0	70
969.0	202
970.0	452
970.5	820
971.0	1432
971.5	2251
972.0	3344
972.5	4588
973.0	6003
973.5	7552
974.0	9198

PLATE D-4

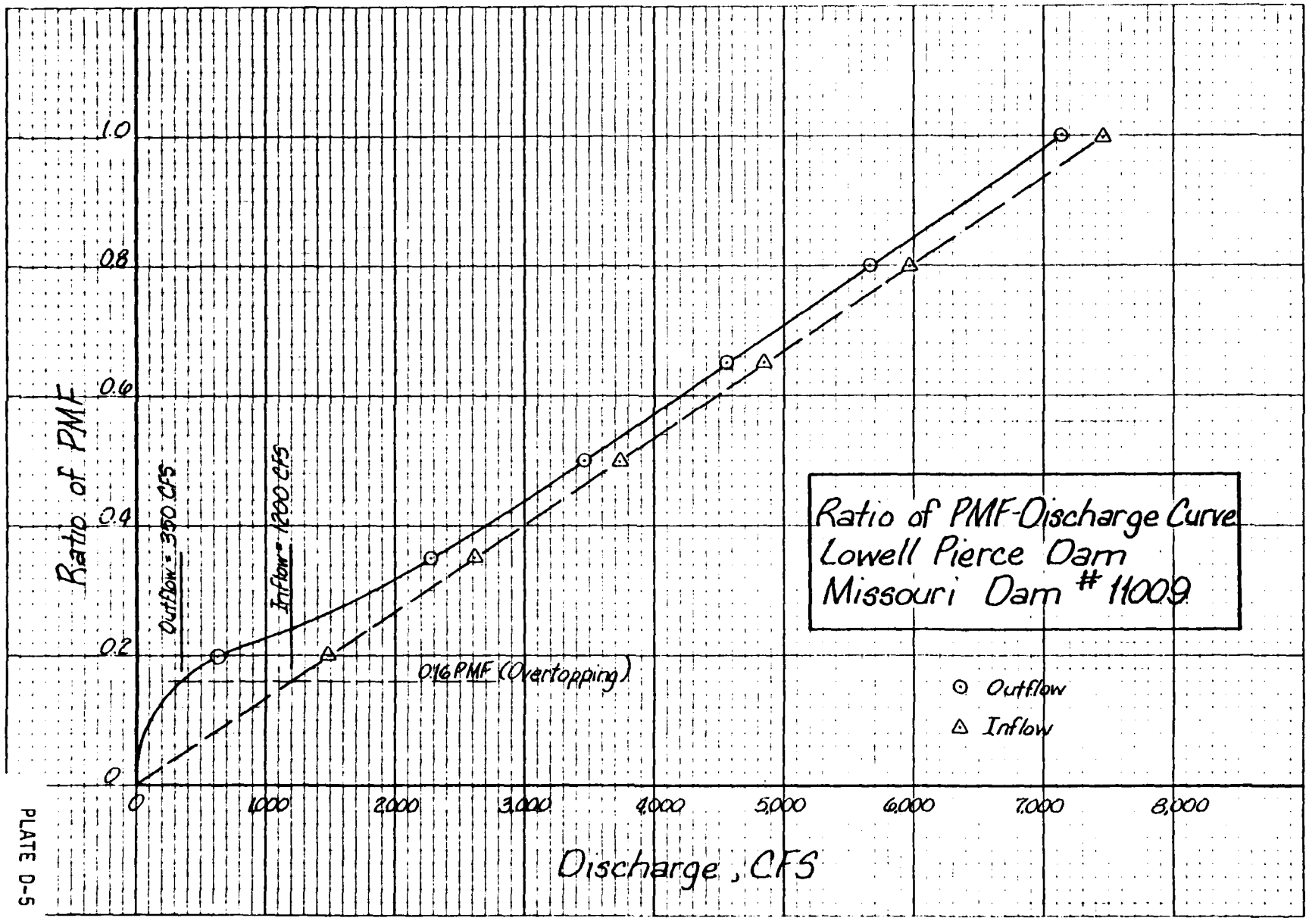

Ratio of PMF
1.0
0.8
0.6
0.4
0.2
0
Outflow = 350 CFS
Inflow = 1200 CFS
0.16 PMF (Overtopping)
Ratio of PMF-Discharge Curve
Lowell Pierce Dam
Missouri Dam # 11009
Outflow
Inflow
0
1000
2000
3000
4000
5000
6000
7000
8000
Discharge, CFS

PLATE D-5

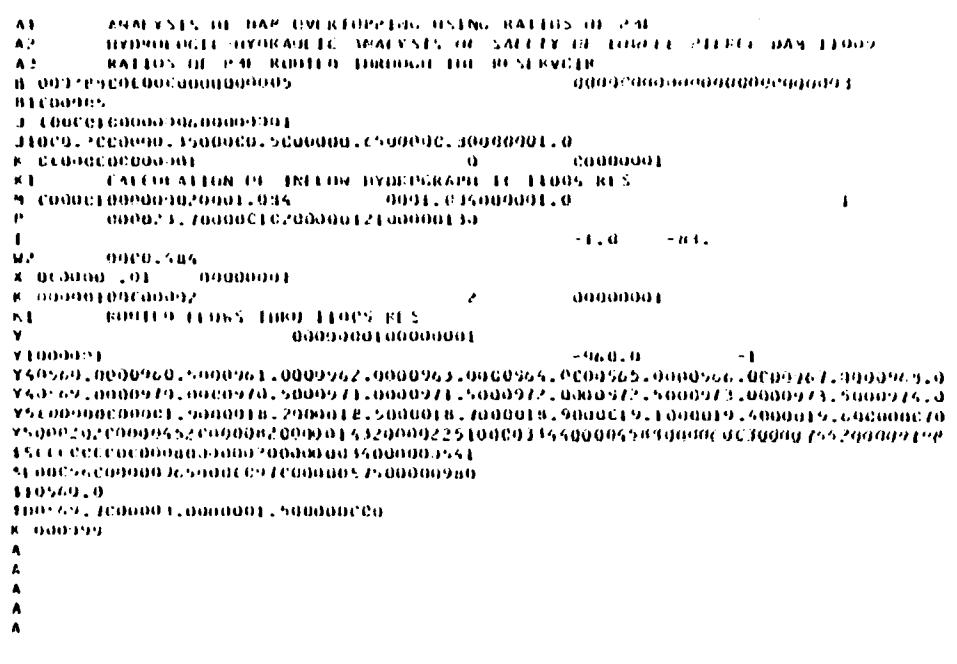


PLATE D-6

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********

RUN  DATE  79/06/22.
     TIME  13.10.35.
```

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF LOWELL PIERCE DAM 11009
RATIOS OF PMF ROUTED THROUGH THE RESERVOIR

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	5	0	0	0	0	0	3	0
			JOPER	NMT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 6 LRTIO= 1

RTIOS= .20 .35 .50 .65 .80 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

CALCULATION OF INFLOW HYDROGRAPH TO 11009 RES

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
000001	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	1.08	0.00	1.08	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.70	102.00	121.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOR	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-83.00	0.00	0.00

CURVE NO = -83.00 WETNESS = -1.00 EFFECT CN = 83.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .48

RECESSION DATA
STRTQ= 0.00 QRCSN= -.01 RTIOR= 1.00

UNIT HYDROGRAPH 31 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .48 VOL= 1.00

71.	210.	429.	711.	918.	991.	980.	879.	750.	575.
427.	327.	257.	200.	153.	119.	92.	71.	54.	42.
33.	25.	20.	15.	12.	9.	8.	6.	4.	2.
1.									

PLATE D-7

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 3

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3732.	1351.	413.	413.	118914.
CMS	106.	38.	12.	12.	3367.
INCHES		11.60	14.17	14.17	14.17
MM		294.52	359.99	359.99	359.99
AC-FT		670.	819.	819.	819.
THOUS CU M		826.	1010.	1010.	1010.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 4

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4851.	1757.	537.	537.	154588.
CMS	137.	50.	15.	15.	4377.
INCHES		15.07	18.42	18.42	18.42
MM		382.87	467.99	467.99	467.99
AC-FT		871.	1065.	1065.	1065.
THOUS CU M		1074.	1313.	1313.	1313.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 5

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5971.	2162.	661.	661.	190262.
CMS	169.	61.	19.	19.	5388.
INCHES		18.55	22.68	22.68	22.68
MM		471.23	575.99	575.99	575.99
AC-FT		1072.	1310.	1310.	1310.
THOUS CU M		1322.	1616.	1616.	1616.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 6

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	7464.	2702.	826.	826.	237827.
CMS	211.	77.	23.	23.	6735.
INCHES		23.19	28.35	28.35	28.35
MM		589.04	719.99	719.99	719.99
AC-FT		1340.	1638.	1638.	1638.
THOUS CU M		1653.	2020.	2020.	2020.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTED FLOWS THRU 11009 RES

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
000002	1	0	0	2	0	1	0	0

ROUTING DATA

OLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-960.	-1

STAGE	960.00	960.50	961.00	962.00	963.00	964.00	965.00	966.00	967.00	968.00
	969.00	970.00	970.50	971.00	971.50	972.00	972.50	973.00	973.50	974.00
FLOW	0.00	1.90	18.20	18.50	18.70	18.90	19.10	19.40	19.60	20.00
	202.00	452.00	820.00	1432.00	2251.00	3344.00	4588.00	6003.00	7552.00	9198.00

CAPACITY=	0.	80.	200.	340.	541.
ELEVATION=	960.	965.	970.	975.	980.

CREL	SPWID	COQW	EXPW	ELEVL	COOL	CAREA	EXPL
960.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
969.7	3.0	1.5	0.

STATION 000002, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	2.	2.	2.	2.	3.	4.
5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
14.	15.	16.	17.	18.	18.	18.	18.	18.	18.
18.	18.	18.	18.	18.	18.	18.	18.	18.	18.
18.	18.	18.	18.	18.	18.	18.	18.	18.	19.
18.	18.	18.	18.	18.	18.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
19.	19.	19.	20.	20.	20.	20.	30.	42.	53.
86.	137.	187.	262.	337.	398.	444.	515.	569.	609.
615.	619.	617.	609.	599.	588.	575.	562.	547.	533.
518.	503.	488.	474.	461.	451.	446.	442.	436.	429.
420.	409.	396.	381.	364.	347.	330.	313.	296.	280.
264.	249.	235.	222.	209.	199.	193.	187.	181.	176.
171.	165.	160.	155.	151.	146.	142.	138.	134.	130.
126.	123.	119.	116.	113.	110.	107.	104.	101.	99.
96.	93.	91.	89.	86.	84.	82.	80.	79.	77.
75.	73.	72.	70.	69.	69.	69.	69.	67.	67.
66.	66.	65.	65.	64.	64.	63.	63.		

STORAGE

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

(IVM)

STATION 000002, PLAN 1, RATIO 4

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	2.
2.	4.	6.	9.	12.	16.	18.	18.	18.	18.
18.	18.	18.	18.	18.	19.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	20.	20.	20.	20.
22.	28.	35.	41.	47.	53.	59.	64.	70.	85.
99.	113.	127.	139.	152.	165.	179.	195.	225.	267.
316.	370.	427.	536.	672.	795.	953.	1094.	1208.	1304.
1388.	1472.	1557.	1629.	1690.	1742.	1785.	1821.	1851.	1878.
1906.	1939.	1979.	2027.	2080.	2135.	2189.	2240.	2293.	2338.
2370.	2392.	2404.	2415.	2440.	2517.	2712.	3100.	3760.	4660.
5691.	6541.	7042.	7152.	6924.	6445.	5842.	5251.	4703.	4261.
3885.	3567.	3311.	3121.	2961.	2827.	2713.	2610.	2513.	2419.
2330.	2248.	2189.	2132.	2081.	2036.	1996.	1953.	1898.	1819.
1709.	1569.	1414.	1278.	1135.	993.	861.	772.	702.	636.
576.	520.	470.	441.	424.	407.	391.	375.	360.	346.
333.	321.	309.	298.	288.	279.	270.	261.	253.	246.
239.	233.	227.	222.	217.	212.	208.	204.	201.	199.
197.	195.	193.	192.	190.	189.	187.	186.	184.	183.
182.	180.	179.	178.	177.	176.	175.	174.	173.	172.
171.	170.	170.	169.	168.	167.	167.	166.		

STORAGE

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	1.	1.	1.	1.	1.	1.	1.
1.	1.	2.	2.	2.	2.	2.	2.	2.	3.
3.	3.	3.	3.	4.	4.	4.	5.	6.	7.
8.	9.	10.	12.	13.	15.	16.	18.	20.	22.
24.	26.	28.	30.	32.	34.	36.	39.	41.	43.
46.	48.	51.	53.	56.	58.	61.	64.	66.	69.
72.	74.	77.	80.	93.	85.	88.	91.	94.	97.
100.	103.	105.	108.	111.	114.	117.	120.	123.	126.
129.	132.	135.	138.	141.	144.	147.	149.	152.	155.
157.	160.	162.	165.	167.	169.	172.	175.	178.	182.
187.	192.	198.	203.	208.	213.	217.	220.	223.	225.
227.	229.	230.	231.	232.	233.	234.	235.	235.	236.
236.	237.	237.	238.	239.	240.	241.	242.	243.	243.
244.	244.	244.	244.	244.	245.	248.	253.	261.	271.
281.	289.	293.	294.	292.	288.	282.	277.	271.	266.
262.	259.	256.	253.	251.	249.	249.	247.	245.	244.
243.	242.	241.	240.	239.	238.	238.	237.	236.	235.
233.	230.	229.	224.	221.	218.	215.	212.	210.	207.
205.	203.	201.	199.	197.	196.	194.	193.	191.	190.

189.	187.	186.	185.	184.	183.	182.	182.	181.	180.
190.	179.	178.	178.	177.	177.	177.	176.	176.	175.
175.	175.	174.	174.	174.	174.	173.	173.	173.	173.
172.	172.	172.	172.	171.	171.	171.	171.	171.	171.
170.	170.	170.	170.	170.	170.	170.	169.		

STAGE

960.0	960.0	960.0	960.0	960.0	960.0	960.0	960.0	960.0	960.0
960.0	960.0	960.0	960.0	960.0	960.0	960.0	960.0	960.0	960.0
960.0	960.0	960.0	960.0	960.0	960.0	960.0	960.0	960.0	960.0
960.0	960.0	960.0	960.0	960.0	960.0	960.0	960.0	960.0	960.0
960.0	960.0	960.0	960.0	960.0	960.0	960.0	960.0	960.0	960.0
960.0	960.0	960.0	960.0	960.0	960.0	960.1	960.1	960.1	960.1
960.1	960.1	960.1	960.1	960.1	960.1	960.1	960.1	960.2	960.2
960.2	960.2	960.2	960.2	960.2	960.2	960.3	960.3	960.4	960.4
960.5	960.6	960.6	960.7	960.8	960.9	961.0	961.1	961.2	961.4
961.5	961.6	961.7	961.9	962.0	962.1	962.3	962.4	962.6	962.7
962.9	963.0	963.2	963.3	963.5	963.6	963.8	964.0	964.1	964.3
964.5	964.6	964.8	965.0	965.1	965.2	965.3	965.5	965.6	965.7
965.8	965.9	966.1	966.2	966.3	966.4	966.6	966.7	966.8	966.9
967.0	967.2	967.3	967.4	967.5	967.7	967.8	967.9	968.0	968.1
968.2	968.3	968.4	968.5	968.6	968.7	968.8	968.9	969.1	969.3
969.5	969.7	969.9	970.1	970.3	970.5	970.6	970.7	970.8	970.9
971.0	971.0	971.1	971.1	971.2	971.2	971.2	971.2	971.3	971.3
971.3	971.3	971.3	971.4	971.4	971.4	971.5	971.5	971.5	971.5
971.6	971.6	971.6	971.6	971.6	971.6	971.7	971.9	972.2	972.5
972.9	973.2	973.3	973.4	973.3	973.1	972.9	972.7	972.5	972.4
972.2	972.1	972.0	971.9	971.8	971.8	971.7	971.7	971.6	971.6
971.5	971.5	971.5	971.4	971.4	971.4	971.3	971.3	971.3	971.2
971.2	971.1	971.0	970.9	970.8	970.6	970.5	970.4	970.3	970.3
970.2	970.1	970.0	970.0	969.9	969.8	969.8	969.7	969.6	969.6
969.5	969.5	969.4	969.4	969.3	969.3	969.3	969.2	969.2	969.2
969.1	969.1	969.1	969.1	969.1	969.0	969.0	969.0	969.0	969.0
969.0	968.9	968.9	968.9	968.9	968.9	968.9	968.9	968.9	968.9
968.8	968.8	968.8	968.8	968.8	968.8	968.8	968.8	968.8	968.8
968.8	968.8	968.8	968.7	968.7	968.7	968.7	968.7		

PEAK OUTFLOW IS 7152. AT TIME 16.17 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	7152.	2659.	740.	740.	213235.
CMS	203.	75.	21.	21.	6038.
INCHES		22.82	25.41	25.41	25.41
MM		579.65	645.54	645.54	645.54
AC-FT		1319.	1469.	1469.	1469.
THOUS CU M		1627.	1811.	1811.	1811.

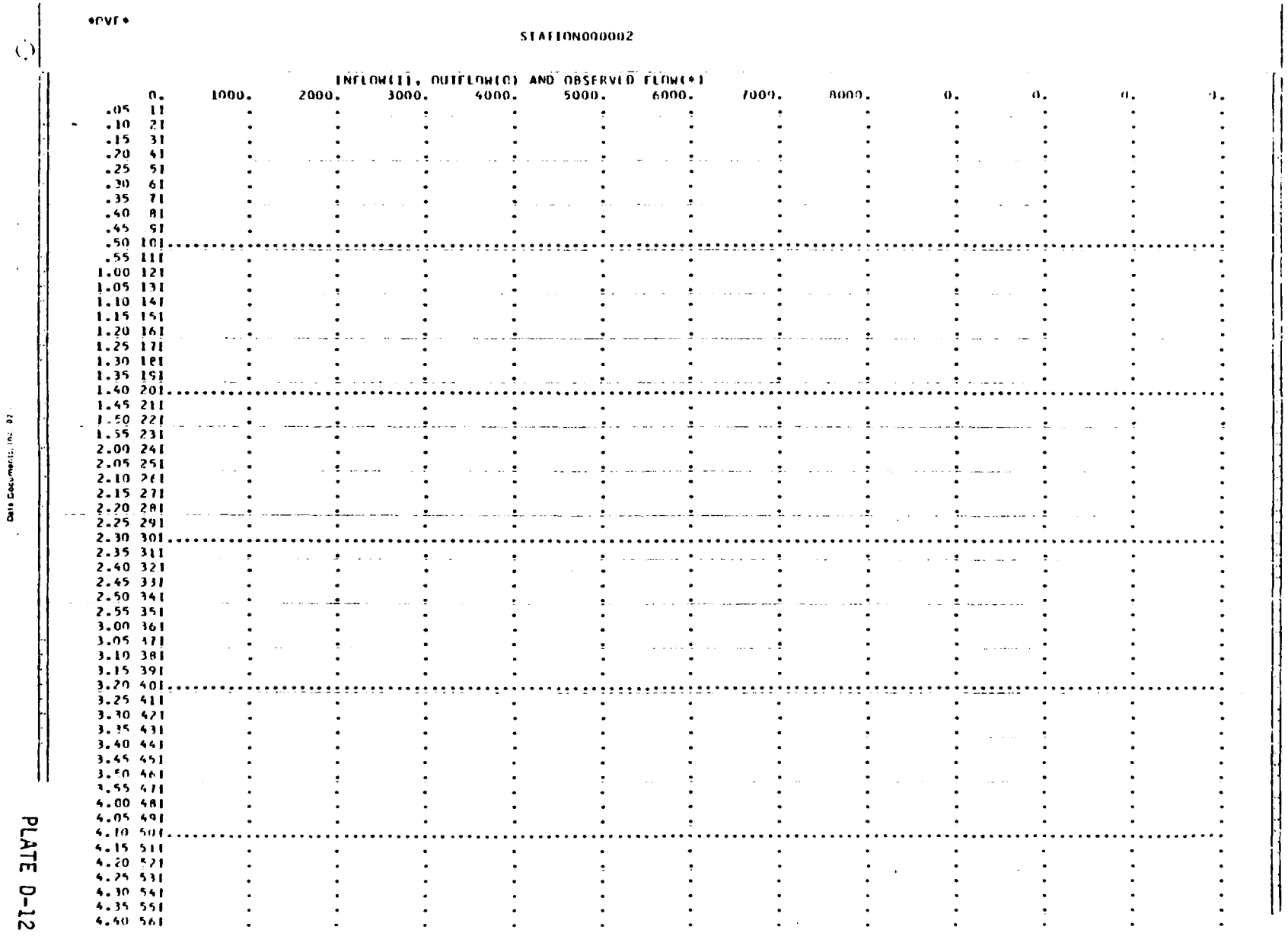

DVF
STATION000002
INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)
0. 1000. 2000. 3000. 4000. 5000. 6000. 7000. 8000. 0. 0. 0. 0.
.05 11
.10 21
.15 31
.20 41
.25 51
.30 61
.35 71
.40 81
.45 91
.50 101
.55 111
1.00 121
1.05 131
1.10 141
1.15 151
1.20 161
1.25 171
1.30 181
1.35 191
1.40 201
1.45 211
1.50 221
1.55 231
2.00 241
2.05 251
2.10 261
2.15 271
2.20 281
2.25 291
2.30 301
2.35 311
2.40 321
2.45 331
2.50 341
2.55 351
3.00 361
3.05 371
3.10 381
3.15 391
3.20 401
3.25 411
3.30 421
3.35 431
3.40 441
3.45 451
3.50 461
3.55 471
4.00 481
4.05 491
4.10 501
4.15 511
4.20 521
4.25 531
4.30 541
4.35 551
4.40 561

PLATE D-12

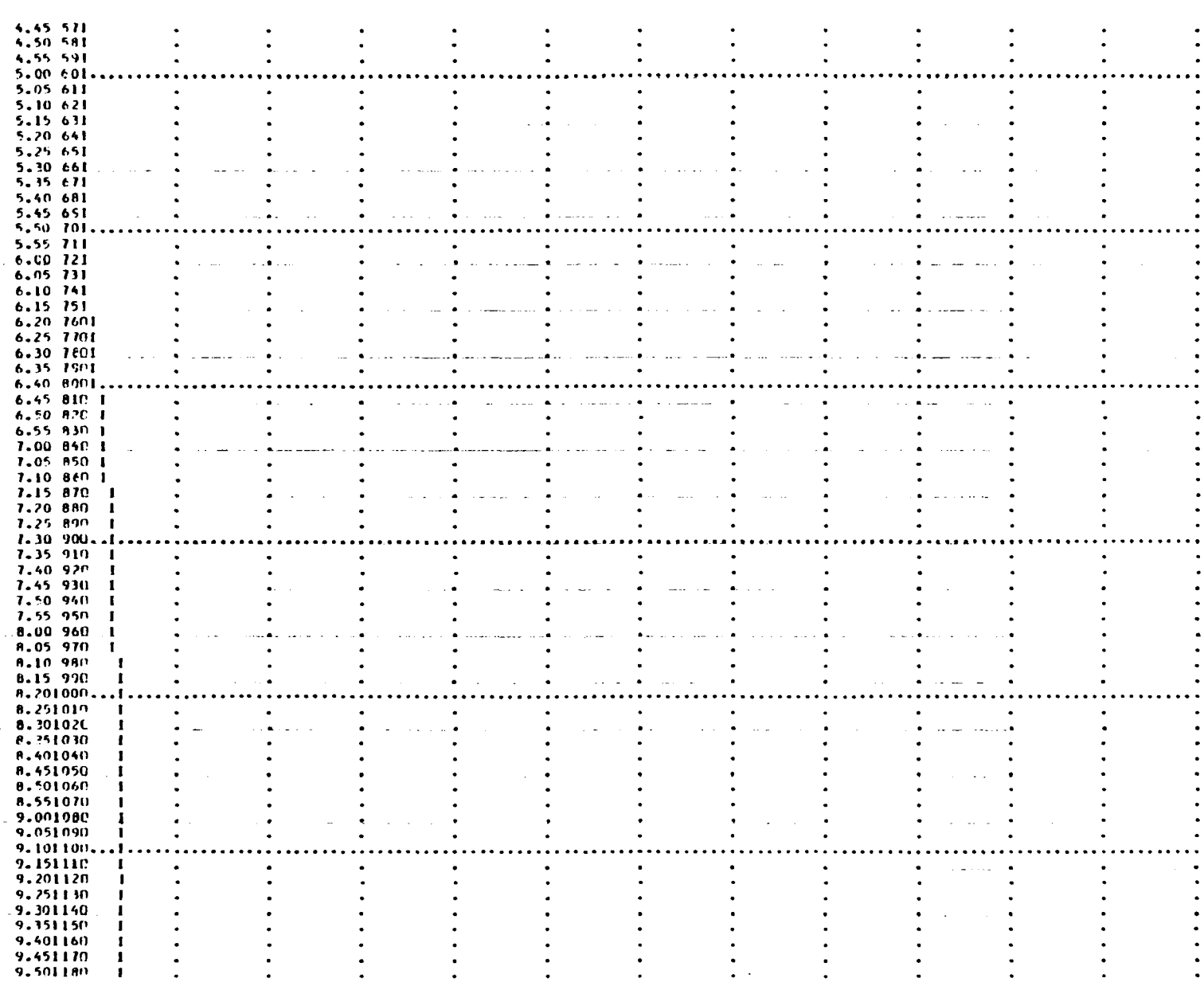
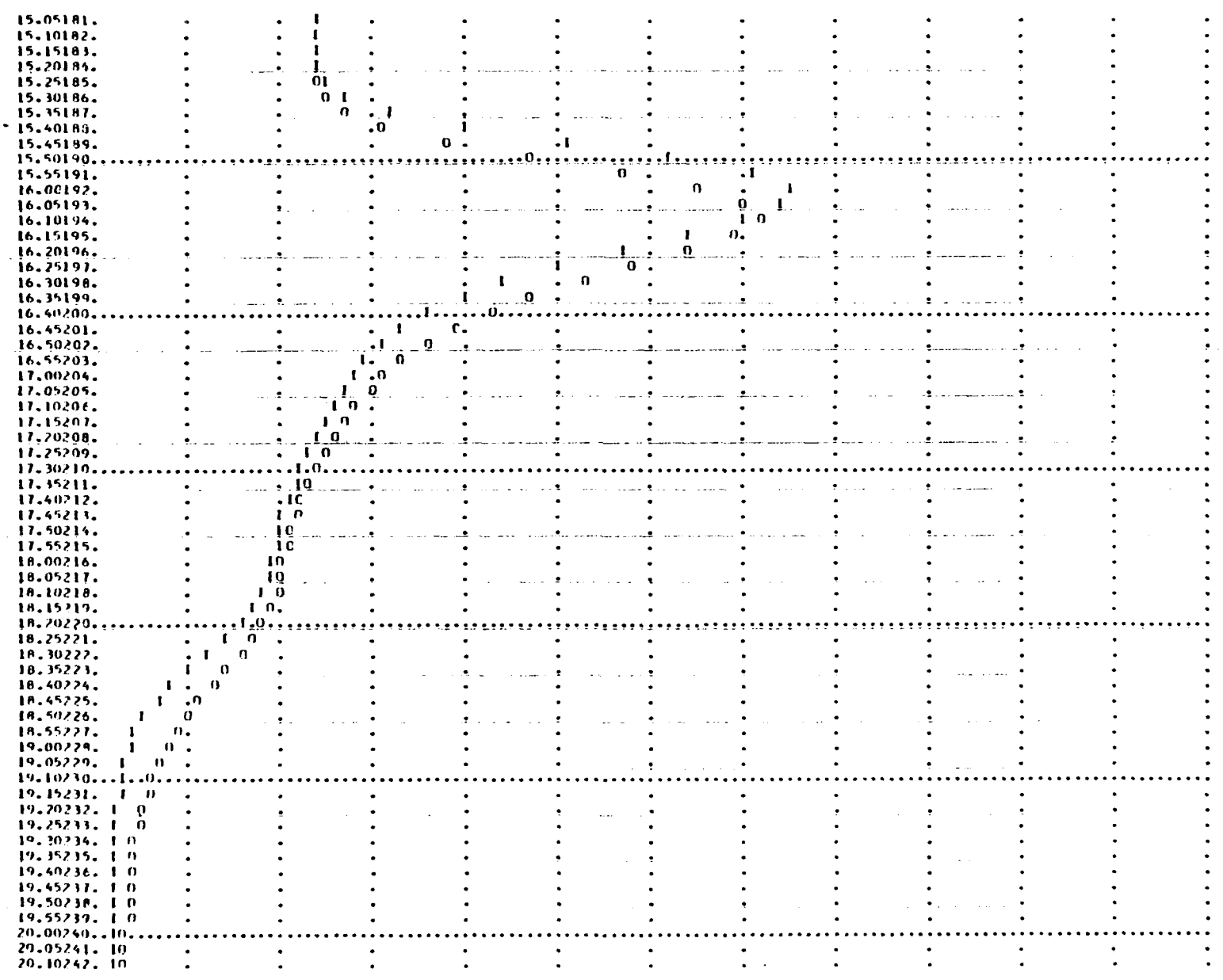


PLATE D-13

PLATE D-14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15.30186.
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16.00192.
16.05193.
16.10194.
16.15195.
16.20196.
16.25197.
16.30198.
16.35199.
16.40200.
16.45201.
16.50202.
16.55203.
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17.45213.
17.50214.
17.55215.
18.00216.
18.05217.
18.10218.
18.15219.
18.20220.
18.25221.
18.30222.
18.35223.
18.40224.
18.45225.
18.50226.
18.55227.
19.00228.
19.05229.
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19.30234.
19.35235.
19.40236.
19.45237.
19.50238.
19.55239.
20.00240.
20.05241.
20.10242.

PLATE D-15

20.15241.10
20.20244.10
20.25245.00
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20.35247.10
20.40248.10
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23.50286.10
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0.00288.10

PLATE D-16

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS					
				RATIO 1 .20	RATIO 2 .35	RATIO 3 .50	RATIO 4 .65	RATIO 5 .80	RATIO 6 1.00
HYDROGRAPH AT	000001	1.08	1	1493.	2612.	3732.	4851.	5971.	7464.
		(2.81)	(	42.27)(	73.97)(	105.68)(	137.38)(	169.08)(	211.35)(
ROUTED TO	000002	1.08	1	619.	2288.	3457.	4563.	5679.	7152.
		(2.81)	(	17.54)(	64.79)(	97.90)(	129.20)(	160.82)(	202.51)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	960.00	960.00	969.70
STORAGE	0.	0.	193.
OUTFLOW	0.	0.	377.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	970.23	.53	206.	619.	2.42	16.83	0.00
.35	971.52	1.82	242.	2238.	3.83	16.25	0.00
.50	972.05	2.35	257.	3457.	5.17	16.17	0.00
.65	972.49	2.79	270.	4563.	6.00	16.17	0.00
.80	972.89	3.19	281.	5679.	6.50	16.17	0.00
1.00	973.37	3.67	294.	7152.	7.08	16.17	0.00